

thoroughly swabbed out with the biniodide in alcohol or some strong antiseptic solution, and packed with iodoform gauze soaked in an antiseptic. If a definite piece of placenta is found, this, together with blood clots, should be taken away, followed by swabbing and gauze packing. If the cavity is large and the surface irregular, due to hypertrophied and necrotic decidua, the patient's safety can only be ensured by its complete removal. There is no doubt that this is most efficiently done by the use of a suitable curette. The fingers alone cannot effect a complete removal of all placental and decidual tissue, especially if it is firmly adherent.

#### Curettage.

The most divergent views have been held as to the place of the curette in the puerperal uterus. The modern tendency is to restrict its use, and many entirely reject it. In Germany the curette is almost given up, and local treatment is restricted to swabbing and packing the uterus with gauze soaked in absolute alcohol or some non-toxic antiseptic. In France, on the other hand, Pinard, Dolèris, and others are strong advocates of early and thorough curettage in all cases of uterine infection. They insist on the importance of early operation with the object of disinfecting the uterus by removal of all necrotic tissue, including the superficial part of the decidual mucosa, which, if not already infected, will speedily become so. The results in skilled hands show that curettage is innocuous if carried out before the bacterial invasion has extended into the walls of the uterus. In septic infection of the endometrium, and if the organisms have already invaded the lymphatics and blood vessels, the results of any method of local treatment are uncertain. We possess, however, no clinical means of ascertaining the depth or degree of invasion, and many patients who show all the signs of septic infection manifest the most striking improvement after curettage skilfully performed. Very grave toxæmia may be produced by a superficial streptococcal invasion of the endometrium.

The arguments against curettage are: (1) The difficulty of thoroughly going over the whole interior of the uterus; (2) the danger of perforation; (3) that the finger can be used equally well to remove retained products; (4) that the curette may cause generalization of a local infection either by removing the leucocyte protective zone which is thrown out by the uterine wall to prevent the spread of infection, or by opening up the mouths of vessels and lymphatics which become the site of fresh inoculation. Curettage of the puerperal uterus is a serious operation, and it is difficult to carry out thoroughly; if badly done it is distinctly harmful. The cavity of the uterus is large, and unless it is gone over systematically much of the infected decidua will be left behind. Haemorrhage may be very free owing to atony of the uterine muscle. It is very desirable that a method of treatment should be devised which is efficient and yet absolutely safe. The "écouvillon" or brush curette of Budin and Dolèris effects a very complete removal of retained products and necrotic decidua. This instrument resembles a bottle brush, but is made of strong quills. It is used to scrub the interior of the uterus by vertical and rotary movements. All débris is then removed, and the cavity is left quite smooth. A douche is then given and the uterus firmly packed with gauze soaked in alcohol or some strong antiseptic. It is essential to give chloroform, as it is a painful process, and dilatation of the cervix may be required. The results are excellent if carried out at any early period of the disease, and this plan of treatment is worthy of more general adoption. There is general agreement that in certain types of infection all vigorous local treatment is harmful. Such are (1) general septicaemia with evidence of septic phlebitis or infiltration of the pelvic connective tissue; (2) peritonitis or inflammation of the appendages, except as a preliminary to some surgical operation such as drainage of the posterior *cul-de-sac*; (3) gonorrhoeal endometritis: these cases usually recover, unless a "mixed" infection is present. If curettage is thoroughly carried out it is rarely necessary to repeat it. If the operation has been of marked benefit and the symptoms recur it may be repeated, but usually uterine douches or gauze packing are quite sufficient. If no good result follows little is to be done by further intrauterine treatment. Careful watch must be kept for evidence of localization of inflammatory products.

#### Posterior Vaginal Section.

This operation may be carried out as supplementary to curettage if symptoms of pelvic peritonitis are present. The finger is introduced into the peritoneal cavity, any fluid

evacuated and drainage by a tube or gauze packing established. This procedure is free from danger, and in some cases is remarkably successful in checking the infective process.

#### Hysterectomy.

This operation has been performed in 137 published cases with a mortality of 63 per cent.<sup>2</sup> It has been done for the most diverse conditions, and its value and limitations can only be gauged after a complete study of the cases in detail.

It has been conclusively shown that the operation in cases of puerperal septicaemia, without localization of the infection, is most dangerous, the mortality amounting to 70 per cent., and it is probable that some which recovered would have had an equally good chance without the operation. If the uterus contains placenta or débris accompanied by grave infection, hysterectomy is much more dangerous than curettage and packing, and should never be done. The best results have been obtained in cases of peri-uterine suppuration, gangrene of the uterus, or necrotic myomata, but these rarely arise in the early days of the puerperium. The symptoms of infection do not afford any reliable guide as to when to operate in acute cases, and in these the operation is very fatal and should not be performed.

#### Use of Antistreptococcal Serum.

This has now been before the profession for ten years, yet there is no general agreement as to its value in puerperal septicaemia. This is due to various reasons: the enormous variability of puerperal infection; the different kinds of serum used; the rarity of complete bacteriological investigation. It is quite unscientific to use serum unless streptococci are actually the cause of infection. We know now that many varieties exist, and a serum potent against one type may be useless against others. A "polyvalent" serum has recently been introduced to meet this difficulty, but it is too early as yet to define its value.

The following conclusions may be stated:

1. The serum is innocuous if carefully prepared and injected with due precaution.
2. It must be administered early in the disease and in large doses—20 c.cm. twice or thrice in twenty-four hours in severe cases.
3. If administered early and in large doses definite improvement is observed in a considerable proportion of cases.
4. All statistics are valueless unless accompanied by bacteriological details.

The most recent work on the subject has been done by Bumm,<sup>3</sup> who is a strong advocate for the use of serum. In each case a bacteriological examination was made. He used it in 53 cases of streptococcal endometritis, 32 of which were severe, the blood containing streptococci in 17 cases. In 21—that is, 35 per cent.—the serum had a definite effect, as shown by fall in pulse and temperature; in 17 it was useless. Five patients died. In septic peritonitis and in endocarditis the serum had no effect. The serum was given in 3 cases of septicaemia, the blood being loaded with streptococci; in 2 cases the serum had no effect; 1 case recovered with thrombosis of the iliac vein.

It would seem, therefore, that serum should be given in all severe infections, and that it is of real value in a certain proportion of cases.

#### REFERENCES.

- <sup>1</sup> *Trans. North of England Gyn. Soc.*, 1893. <sup>2</sup> Christeanu, *Rev. de Gynéc.*, July-August, 1904. <sup>3</sup> *Munch. med. Woch.*, September, 1904.

## THE INCREASING USE OF LEAD AS AN ABORTIFACIENT;

A SERIES OF THIRTY CASES OF PLUMBISM.\*

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THE ecobolic properties of lead have been well known to the medical profession for a very long time, and every textbook dealing with the subject of plumbism refers to the frequency with which females suffering from this affection tend to abort. The idea of using this drug primarily as an abortifacient would never occur to any one having any medical knowledge; it would resemble too closely the Chinaman's method of obtaining roast pig by burning down the pigsty.

\* Read before the Yorkshire Branch of the British Medical Association at Bradford, January, 1905.

Unfortunately, the quack and the patent pill vendor, devoid of responsibility, aiming only at results and heedless of consequences, have discovered in lead a drug which is at least effective and accomplishes the desired object.

So far as I can ascertain from the literature dealing with plumbism, the common use of this drug by the laity for the purpose of procuring abortion is only of comparatively recent date, perhaps some ten or fifteen years.

To Dr. F. M. Pope, of Leicester,<sup>1</sup> belongs the credit of first making the observation. In 1893 he reported two fatal cases of plumbism, the source of which was discovered after death to be diachylon, taken for the purpose of bringing on abortion. Since that time others have reported similar cases, amongst whom I may mention G. F. Crooke of Birmingham,<sup>2</sup> Bell Taylor of Nottingham,<sup>3</sup> Branson,<sup>4</sup> Ransom of Nottingham,<sup>5</sup> Wrangham of Leicester and Sheffield,<sup>6</sup> Scott of Nottingham,<sup>7</sup> Jacob and Trotman,<sup>8</sup> and Layton of Walsall.<sup>9</sup>

It will thus be seen that this pernicious practice prevails notably in the Midland districts of England, and that it is gradually appearing to widen its circle. It seems to have reached Sheffield as early as 1901, as shown by Wrangham's case published in that year, in which insanity was produced, so that the patient came under his care in the South Yorkshire Asylum. It does not, however, seem to have become at all widely spread here until the last year or two. It is possible that the cause of the plumbism has been overlooked in many cases, and cases have occurred but have been attributed to the water supply, which has in the past caused widespread plumbism in the Sheffield district.

During the last few months, however, there has been a considerable number of similar cases of plumbism in women, some of which have been definitely traced to the wilful taking of various preparations for the purpose of procuring abortion, whilst others fail to show any other cause for their symptoms, and in them the same source is highly probable. So numerous have the cases become latterly, that I feel it is desirable once again to call the attention of the profession to this growing evil, which causes such terrible suffering and such serious after-results to these ignorant women. Another reason for bringing this forward is that I find so many medical men are quite unaware of the possibility or likelihood of such a thing, and hence are not on the look-out for anything of the kind. When I say that a few weeks ago I had three women in one ward at the Royal Hospital all gravely ill from this cause, and that at the same time I saw a fourth case in a neighbouring town which proved fatal, and that in none of these four cases had the medical men in charge of them any suspicion as to the true nature of the disease or of this traffic in lead as an abortifacient, I think no apology is necessary for bringing the matter forward. I am also anxious to hear from members of the Branch how far the practice has reached other Yorkshire centres of population.

Some of the cases I have seen have been acute in character, and presented symptoms of abdominal pain, with vomiting and constipation, strongly suggestive of abdominal disease. These cases are most likely to lead to an error of diagnosis, as has been pointed out by Ransom and others. They imply the taking of large doses of poison. It is mainly in connexion with this use of diachylon as an abortifacient that most of the papers hitherto published have dealt; but we have now an equally serious, if less immediately grave, problem to deal with—namely, the sale of quack "female irregularity" pills, containing only minute traces of lead, and leading insidiously to the most chronic forms of plumbism.

When first I began to see these cases I suspected that there must be some recurrence of lead in the Sheffield drinking water. Only a few years ago we in Sheffield had the unenviable notoriety of an extensive and serious outbreak of plumbism due to this cause. That, however, thanks to the treatment of the water supply by alkali, previous to its reaching the city, is practically a thing of the past. I communicated with the Medical Officer of Health (Dr. Scurlfield), and asked him to kindly inquire into the matter. He assured me that there was no reason to suspect the water supply as the cause in any of the cases. He also kindly furnished me with a list of cases of plumbism which had been reported to him during 1904, and which could not be satisfactorily accounted for by occupation, etc. They were as follows: From May 30th to October 1st seven such cases had been reported. They were all women, and lived in quite different parts of the city. All had been carefully investigated by his officers. Their ages were 28, 38, 22, 40, 24, and in one it is not given. This fact that they were all of childbearing age is also suggestive.

None of them worked as file cutters—a common additional cause of plumbism in this district.

As the number of cases I saw multiplied, the cause became more evident, but it was some time before I was able to find out any one definite source of the poison. This is not surprising, as the patients usually deny having taken anything, and are so afraid of getting into trouble that they dare not admit such a thing. However, in one case I was successful, and myself purchased the article from a well-known firm of druggists for purposes of analysis. The label says, "Dr. —'s famous female pills—are world renowned and unequalled. Dose.—Two to be taken four times a day." They bear an address in London, and they are protected by a wrapper marked, "This stamp implies no Government guarantee." With them is given an objectionable circular, advertising all kinds of pessaries and protectives. Besides this there is a special piece of paper, which reads as follows: "They must be taken for a week before each month. (The extra strong or the special strength need only to be taken for four or five days) continuing them until effective. They will not injure the most delicate constitution nor infants at the breast."

A quantitative analysis of these pills was kindly made for me by one of my colleagues at University College, an expert analytical chemist, who sends me the following report:

I find lead, but only in a very small amount. The ash of the pills is partly soluble in acid and partly insoluble. There is no doubt about the presence of lead in the insoluble portion, but I have a doubt about it in the soluble portion.

10 pills taken, weight = 2.5577 grams = 39.4653 grains.

#### Metallic Lead Found.

Insoluble residue	...	...	0.24 mg. = 0.0037 grains.
Soluble residue	...	...	0.14 mg. = 0.0021 grains.

#### Quantity of Lead in one Pill.

Insoluble residue	...	...	0.00037 grains.
Soluble residue	...	...	0.00021 grains.

At first sight this appears to be a very minute trace of lead, but if one refers to the quantity of lead in drinking water known to have caused poisonous symptoms, it will be seen that this amount is quite enough to produce the results seen. Thus, Oliver<sup>10</sup> refers to a case produced by drinking water containing 0.0028 gr. per gallon. As the patient could not be expected to drink more than three pints of water per day it would mean  $\frac{3}{8}$ ths of 0.0028 gr. of lead—or 0.001 gr. per day. Now, each of the pills contains 0.0005 gr. of lead, so that if only three were taken daily it would mean 0.0015 gr., whilst eight a day (the quantity recommended on the label) would give 0.004 gr., or  $\frac{1}{25}$ th gr. of lead. It is thus evident that the quantity of lead in these pills is quite sufficient to produce symptoms of plumbism.

Since then I have purchased two other varieties of "female pills" sold in the City and had them analysed. In both of these small quantities of lead have been found. I am assured by competent authorities that there is no likelihood of any lead having accidentally been used in the coating of the pills, or otherwise, and that in all probability it has been put in with a definite object. I have no doubt that the great depression of trade in this district during the last year has induced many women with families to resort to abortifacients.

I now give a list of cases which have either been under my own observation or the details of which have been kindly supplied by my colleagues in the district:

#### CASE I.

A. P., a married woman, aged 35, two children, came to hospital in June, 1903, complaining of "mist" over her eyes. In December, 1902, she had severe abdominal pain, for which she was in bed three weeks, also vomiting. She had two fits, at two months' interval; was unconscious for several days. She was queer in her mind and had to be held in bed. On one occasion she got out of bed and went out in her nightgown. She showed marked anaemia, blue line, and some muscular paralysis. The drinking-water at her house was examined and no lead was found in it. There is in this case no history of a miscarriage, nor was there any suspicion of the possibility of lead having been taken as an abortifacient.

#### CASE II.

E. A., a married woman, aged 31, six children living, admitted to Sheffield Royal Hospital, January 4th, 1904. Abdominal pain seven weeks; attacks of severe colic. Pain in calves. Vomiting. Miscarriage two weeks ago. Blue line. Ulcers in mouth, breath very foul. Marked basophilic granules in erythrocytes. Some albuminuria. The patient denied having taken anything.

#### CASE III.

M. B., married woman, aged 29, two children living, admitted March 2nd, 1904. No miscarriages. Severe colic began four days ago with vomiting and haematemesis four times. Blue line on gums. The

patient began to take diachylon about Christmas, 1903, on account of delayed menstruation. Bought a pennyworth at a time and made it into pills, of which she would take three, four, and five per day. She did this for a fortnight, then stopped, as her menses appeared. She repeated the pills on February 15th to 17th, has had none since. Recovery.

## CASE IV.

J. M., married woman, aged 28, was admitted on October 1st, 1904. Two children living. The following history was given by Dr. B., with whom I saw the case in consultation. The patient had a miscarriage about three weeks previously, and since then has been in a condition of hysterical stupor. Severe headache, appears dazed, passes motions under her, does not answer questions. Extremely anaemic, gums and breath very offensive, with a peculiar sweet metallic odour; well-developed blue line; has had some convulsions; some weakness of anus. After admission she became acutely maniacal and later had delusions. She gradually recovered, and went out two months later. Right disc was swollen and blurred; left disc slightly so; visual field not affected; recovery. No information could be obtained from the patient as to taking pills, but her sister admits that she took some, and her doctor knows she was much distressed at the idea of having another child.

## CASE V.

S. J. M., married woman, aged 29, admitted October 11th, 1904; sent in by Dr. L. Had two children at full term; both died young. The third child was "taken away" at five months because patient was not strong enough to carry it. On admission abdominal pain and vomiting, marked blue line, breath offensive; costive; menses ceased four months ago; swelling of discs; visual field, right eye much diminished. She miscarried in hospital four days after admission. She denies having taken anything for the purpose of bringing on miscarriage. Discharged December, 1904.

## CASE VI.

M. A. S., married woman, aged 29, was admitted on November 8th, 1904. She was sent in by Mr. C. She has two children living and one dead. Began five weeks ago with severe colic, vomiting, and headache. Extreme anaemia; visual field, both eyes reduced to one-third normal on November 18th. Completely recovered December 6th, 1904; discharged recovered December, 1904. She admits that owing to her menses ceasing in August she began to take patent female pills, as she thought she was pregnant. These are the pills referred to above as having been found to contain lead. As a matter of fact she is not pregnant.

## CASE VII.

Mrs. G., aged 34, multipara, living at Parkgate, near Rotherham, was seen in consultation with Dr. — on November 29th, 1904. She had a miscarriage one year ago, and another on October 7th. Since then she had seemed very ill, extremely anaemic, had agonizing headache, also much vomiting. A few days ago she had a slight fit. Last night she had four severe fits, and since then has been in a stuporose condition. She is quite uncontrolled, tosses about, and tries to get out of bed. Extreme anaemia; breath sweet metallic odour and offensive; marked blue line; pulse 120; discs not seen owing to her restlessness; died the following day in convulsions. The actual source of lead not ascertained, but her husband says she had frequently said she would take abortifacients.

## CASE VIII (reported by Mr. Longbottom of Sheffield).

Mrs. W., aged 42. Six children. Severe colic with constipation; abortion; persistent vomiting; blue line; seriously ill for some weeks and profoundly anaemic, but eventually recovered. Admitted having taken pills to procure abortion.

## CASE IX.

Mrs. T., aged 29. Two children. Severe colic and vomiting; blue line; abortion; very ill for three weeks; recovered; admitted taking pills for abortion.

## CASE X.

Mrs. C., aged 36. Three children. Severe colic; blue line; had been irregular, and was afraid she was pregnant, but would not admit having taken anything; recovering slowly.

## CASE XI (reported by Dr. Innes Smith, Brightside, Sheffield).

Mrs. H., 33, four children. Colic, vomiting, cramps, and general collapse; blue line. Denied having taken anything, but had missed a period. August, 1904.

## CASE XII.

Mrs. I., 28, four children (October, 1902). Anaemia, severe colic, constipation, dizziness; blue line; miscarriage. Had been taking "Mrs. O.'s pills."

## CASE XIII.

Mrs. H. B., 37, six children (March, 1901). Colic, vomiting, constipation. Became unconscious; blue line; had missed a period. No history of taking pills.

## CASE XIV.

L. J., 17, single (August, 1900). Haematemesis, constipation, colic, pregnant; blue line. Had been taking "Mrs. O.'s pills." Marriage speedily arranged for and symptoms abated.

CASE XV (reported by Dr. A. Cuff, F.R.C.S., Surgeon, Sheffield Royal Infirmary).

A. S., aged 27. Had recently miscarried; was admitted as possible

intestinal obstruction in November, 1903. Vomiting, colic, constipation. Admitted having taken diachylon pills.

## CASE XVI.

L. W., aged 31; miscarried. Admitted for burns caused by falling into the fire in convulsions. Frequent epileptiform convulsions for several days; maniacal. Blind, no optic neuritis; colic, constipation; blue line. Sent to asylum, where she eventually recovered. Had taken a jam-pot full of diachylon.

## CASE XVII.

E. J., aged 19, miscarried; admitted for supposed intestinal obstruction or pelvic peritonitis in November, 1904; colic, constipation, vomiting, blue line; admitted having taken female pills.

## CASE XVIII (reported by Mr. Rowthorn of Rotherham).

Mrs. H., aged 42, miscarried when three months pregnant, September, 1904; vomiting, constipation, colic, blue line; no lead in water supply examined; no employment in which lead used; has a grown-up family, and resented her pregnancy; denied taking abortifacients; recovered.

Also the following from my out-patient department at the Sheffield Royal Hospital:

CASE	XIX.—V. S., female, aged 37, March 1904.
"	XX.—M. K., " " 21, " "
"	XXI.—L. V., " " 24, May, "
"	XXII.—E. S., " " 28, June "
"	XXIII.—M. R., " " 38, July "
"	XXIV.—N. C., " " 22, " "
"	XXV.—S. M., " " 40, May "
"	XXVI.—A. G., " " ? September
"	XXVII.—M. R., " " 24, August "
"	XXVIII.—E. W., " " ? October "

It will be noticed that all of these patients are women of child-bearing age, usually married, and in most cases mothers of families. They are, as a rule, somewhat older than the age at which, in lead-poisoning outbreaks, the women are mostly attacked—namely, from 18 to 24 years. Of the first 18 cases, of which alone I have any particulars, 11 did miscarry, 1 (a single woman) was pregnant, 5 admitted delayed menstruation, whilst 1 denied any menstrual trouble; 10 out of the 18, or more than half, admitted having taken some form of abortifacient, one died comatose a few hours after the cause was suspected, whilst in some of the others the friends admitted that the patient was very bothered about her real or supposed pregnancy.

When one adds up the total of suffering and illness which the taking of these preparations involves, it assumes a very costly and serious amount. Thus, one mother of a large family died, after suffering for weeks from what her doctor described as the most severe headache he ever saw—literally "agonizing," was his expression. Others became temporarily insane, and had convulsions. All suffered from severe colic and headache. All became profoundly anaemic and required prolonged rest and medical attendance, involving heavy doctor's bills, etc. Some, possibly many, have no doubt laid the foundations of permanent ill-health and future kidney disease. It would surely have been more economical to have had the baby, whilst in many of the cases the delayed menstruation was only a "false alarm"—there was no pregnancy.

The question naturally arises, What can be done to check this undoubtedly growing evil? It is difficult to see. We can hardly prosecute pill vendors for selling a drug which is contained in one of the pills of the *British Pharmacopoeia*. Even if we could, it would be impossible to prevent women from obtaining lead in some other form, whether as diachylon or as lead dust, or even as paint. It seems to me that all we can do is to spread the knowledge amongst our profession that this is going on, so that they may be on the watch for early cases and warn the patients of the dangers to which they are exposing themselves.

Unfortunately, the spreading of this knowledge that lead is an efficient abortifacient is very undesirable, and, in spite of the accompanying warnings, may do more harm than good in the case of those who will venture anything to end their pregnancy.

Since writing the above I have two more cases to record, each of which has some points of interest:

## CASE XXIX.

L. S., married, 25, three children, came to the Royal Hospital on February 6th, 1905, with abdominal pain, severe anaemia, marked blue line; her menses ceased in September, 1904, and she took twelve of "Nurse ———'s pills." On account of her severe symptoms she was removed to a hospital as typhoid fever on September 21st. During her stay there all the positive typhoid signs were absent, and she was diagnosed and discharged as "diarrhoea, anaemia." She informed me that she first heard of these pills "from a lady she met at the Monday afternoon mother's meeting in connexion with her chapel."

CASE XXX (Reported by Mr. Connell, F.R.C.S.E., Surgeon, Sheffield Royal Infirmary).

Married woman, supposed to have intestinal obstruction following recent abortion. Mr. Connell, called in consultation, found marked blue line, constipation, anaemia, etc. The woman admitted having taken "6r pills" in one week.

## REFERENCES.

<sup>1</sup> BRITISH MEDICAL JOURNAL, 1893, vol. ii, p. 255. <sup>2</sup> *Lancet*, 1898, vol. ii, p. 742. <sup>3</sup> *Ibid.*, p. 742. <sup>4</sup> BRITISH MEDICAL JOURNAL, December, 1899, p. 255. <sup>5</sup> *Ibid.*, June and July, 1900. <sup>6</sup> *Ibid.*, 1901, vol. ii, p. 72. <sup>7</sup> *Quarterly Medical Journal*, February, 1902. <sup>8</sup> BRITISH MEDICAL JOURNAL, 1903, vol. i, p. 242. <sup>9</sup> *Ibid.*, 1903, vol. i, p. 349. <sup>10</sup> Allbutt's *System*, vol. ii, p. 964, Lead Poisoning, by Thomas Oliver.

## NEW METHODS OF STUDYING AFFECTIONS OF THE HEART.

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Burnley.

### II.—THE ACTION OF DIGITALIS ON THE HUMAN HEART.

CONSIDERING the number of years during which digitalis has been employed in the treatment of affections of the heart, and considering the great number of experiments that have been performed on animals to determine the action of digitalis, it might be assumed that the nature of the action of the drug was sufficiently well known. But if one critically examines the results of these observations, clinical as well as experimental, no clear conception of the manner in which this drug acts can be obtained. The study of its effect upon my own patients has engaged my attention for many years, and I have collected a large number of observations which show its effect on the movements of the heart. The correct interpretation of these observations baffled me for a long time, but at last two events happened which threw a flood of light upon this subject. The first of these events was the observation that in a large class of patients, for whom digitalis is frequently prescribed, the rhythm of the heart does not proceed from the auricle to the ventricle, but originates in the fibres joining auricle and ventricle (remains of the canalis auricularis), or in the ventricle itself. The reaction to digitalis varies greatly, but the arrhythmia produced by the drug in a heart with the ventricular rhythm differs markedly from the arrhythmia produced in a heart with the normal rhythm. The fact that the rhythm of the heart may be ventricular in origin is beyond the ken of the physiologist and experimental pharmacologist, inasmuch as it is the result of long-standing changes in the heart impossible to produce experimentally; but it must be taken into consideration by all who desire to study the effect of digitalis in the human heart. The second event which enabled me to get a clearer insight into the mode of action of digitalis was the perusal of Professor Wenckebach's book on *Arrhythmia of the Heart*. This author, who had made himself familiar with the most minute details of the action of the individual functions of the heart muscle fibres, drew my attention to the exact meaning of many forms of arrhythmia which I had found resulted from the administration of digitalis. Pursuing the inquiry on the lines laid down by him I was able to explain satisfactorily the mode of action of digitalis in many of the most common and most striking irregularities.

I do not for one moment suggest that I have found out the whole matter of the action of digitalis, because there are many phenomena produced by digitalis with which I do not deal. This paper is concerned mainly with certain modifications of the heart's action produced by digitalis. The interpretation here given may not be found sufficient, because my knowledge is very limited and new facts are cropping up continually, so I have endeavoured as far as possible to give a careful record of the facts with such interpretations as appear most reasonable in my present state of knowledge. In doing this I place on record numerous tracings, for by these only can a true conception of the forms of arrhythmia be acquired. It is surprising how much of the literature on digitalis is taken up with the description of its action on the movements of the heart; the writers contenting themselves, as a rule, with minute verbal descriptions, the result of these descriptions being such a curious mixture of fact and fancy that no accurate notion of the real nature of the arrhythmia can be grasped. When in rare instances tracings have been given I have had no difficulty in recognizing the nature of the arrhythmia.

This inquiry suggests a probable explanation for the curiously discordant results obtained by observers, experimental and clinical, inasmuch as it has been overlooked that digitalis has a peculiar tendency to affect primarily those functions of the heart muscle fibre that have been previously damaged, the result being the production of an arrhythmia due to further depression of those functions. I have found, for instance, that in hearts where the function of conductivity

was normal digitalis has no effect upon this function, though it may materially affect other functions of the heart muscle. But in cases where conductivity could be shown to be depressed digitalis very speedily exaggerated this depression and produced the characteristic dropping out of ventricular systoles. In the handling of the heart in experiments one can readily conceive how easily the delicate organization of the heart may be injured by some trivial accident, and the results obtained by experiment may thus vary according to the nature of the function injured.

Writers frequently urge that certain forms of the drug are more potent or more reliable than others. I have found all forms of the drug equally potent in suitable cases, and equally inefficacious in others. I have usually employed the digitalis in the form of the *B. P.* tincture, of the well-known squill, calomel and digitalis pill, and of the digitaline granules (Nativelle's). It might seem that the advocates of special forms of the drug have unwittingly prescribed it to patients whose hearts were peculiarly susceptible, and have attributed the very striking results to the nature of the drug rather than to the susceptibility of the organ.

Another point which shows the susceptibility of the organism to digitalis is this, that the drug affects all non-striped muscle fibre, and before it can have an appreciable effect on the heart it may grievously affect other muscular organs. I have collected sufficient evidence to incline me to the belief that the "gastric irritation" so frequently produced by digitalis is really due to the action of the drug in the musculature of the digestive tract.

#### A.—ACTION OF DIGITALIS WITH THE NORMAL RHYTHM OF THE HEART.

##### 1. Effect of Digitalis on Stimulus Conduction (Dromotropic Effect).\*

In a paper recently published in this JOURNAL I described how the stimulus for contraction was conveyed from muscle fibre to muscle fibre. The stimulus arises at the mouths of the great veins, passes over the auricle, and reaches the ventricle by the fibres joining auricle and ventricle. By observing the time that elapses between the systole of the auricle and the systole of the ventricle we can gauge the rate of conduction along these fibres. This is shown in tracings of the jugular and carotid pulses, when in the jugular a wave, *a* (Fig. 1), due to the auricle, is frequently present, and is immediately followed by a wave, *c*, due to the carotid. The time between *a* and *c* represents the time that the stimulus takes to cross the fibres between auricle and ventricle. The conductivity may be considered normal when the *a-c* interval does not exceed one-fifth of a second. When this function is normal, it is doubtful if digitalis can effect it. At all events, I have pushed it in many cases until other functions of the heart were affected, and until severe gastric disturbances resulted, without the slightest sign of conductivity being delayed. But when conductivity is depressed—that is to say, when the *a-c* interval is more than one-fifth of a second—then digitalis may depress this function with great readiness. Patients may have a slight depression of conductivity for years, and during that time the rhythm of the heart may be invariably regular. Such patients are, however, exceedingly susceptible to the influence of digitalis, and a very small quantity of the drug may produce an arrhythmia due to the dropping out of ventricular systoles. The auricle will continue to contract with perfect regularity, but the stimulus occasionally fails to cross the fibres that connect auricle and ventricle.

#### CASE I.

Female, aged 24. She was under my care in 1900, and I had prescribed digitalis, and phenomena similar to what I am about to describe supervened. She had rheumatic fever in 1902. She married early in 1903,

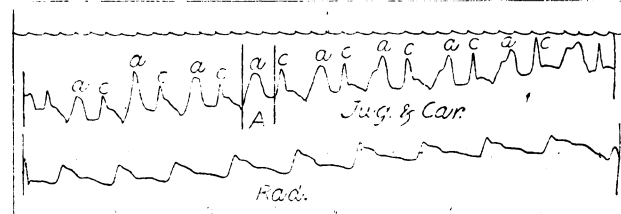


Fig. 1.—Simultaneous tracings of the jugular and carotid pulses with the radial, showing that the *a-c* interval (Space A) is twice the normal period (two-fifths of a second in place of one-fifth), indicating a delay in the stimulus passing from auricle to ventricle. The time marking here and in the other figures represents one-fifth seconds.

and consulted me on October 4th, 1903, being at that time four months pregnant. The heart's dullness was only slightly increased.

\* This and kindred terms used afterwards have been employed by Engelmann, and are bound to be permanently used in the literature on the heart.